

## **CLAIMS**

### **We claim:**

1. An acrylic urethane (meth)acrylate oligomer, which comprises an acrylic urethane backbone comprising a reaction product of an acrylic polyol and a diisocyanate, which backbone is capped with a hydroxy(meth)acrylate, the acrylic urethane (meth)acrylate oligomer comprises residues in the following order :

hydroxy(meth)acrylate - (diisocyanate - acrylic polyol)<sub>n</sub> - diisocyanate -  
hydroxy(meth)acrylate ("structure 1")

where n is 1 to 10.

2. The oligomer according to claim 1, wherein the acrylic polyol comprises a reaction product of a polymer or copolymer of acrylic monomers with a hydroxy containing chain transfer agent, a hydroxy containing initiator, and mixtures thereof.

3. The oligomer according to claim 2, wherein the acrylic monomers comprise ethyl acrylate, ethyl hexyl acrylate, or butyl acrylate.

4. The oligomer according to claim 2, wherein the hydroxy containing chain transfer agent or hydroxy containing initiator comprises a diol.

5. The oligomer according to claim 1, wherein the acrylic polyol has a number average molecular weight as measured by measured by gel permeation chromatography of 1000 to 5000.

6. The oligomer according to claim 1, wherein the diisocyanate comprises 3-isocyanatomethyl-3,5,5-trimethylcyclohexylisocyanate (isophorone diisocyanate or IPDI), 2,4-toluene diisocyanate and 2,6-toluene diisocyanate as well as mixtures of these

diisocyanates (TDI); 4,4'-diphenylmethane diisocyanate (MDI), 2,4'-diphenylmethane diisocyanate, 4,4'-dicyclohexyldiisocyanate or reduced MDI (also known as dicyclohexanemethane diisocyanate), meta- and para-tetramethyl xylene diisocyanate (TXMDI), hydrogenated meta-tetramethyl xylene diisocyanate [1,3-bis(isocyanatemethyl)cyclohexane], hexamethylene diisocyanate (HDI), norbornane diisocyanate (NBDI), 2,2,4- and 2,4,4-trimethylenehexamethylene diisocyanate (TMDI), 1,5-naphthylene diisocyanate (NDI), dianisidine diisocyanate, di(2-isocyanatoethyl)bicyclo[2.2.1]-hept-5-ene-2,3-dicarboxylate, 2,4-bromotoluene diisocyanate, 2,6-bromotoluene diisocyanate, 2,4-/2,6-bromotoluene diisocyanate, 4-bromo-meta-phenylene diisocyanate, 4,6-dibromo-meta-phenylene diisocyanate and mixtures thereof.

7. The oligomer according to claim 1, wherein the diisocyanate comprises 3-isocyanatomethyl-3,5,5-trimethylcyclohexylisocyanate (isophorone diisocyanate or IPDI) or 2,4-toluene diisocyanate and 2,6-toluene diisocyanate as well as mixtures of these diisocyanates (TDI).

8. The oligomer according to claim 1, wherein the hydroxy(meth)acrylate comprises 2-hydroxyethyl acrylate (HEA), 2-hydroxyethylmethacrylate (HEMA); 2-hydroxypropyl meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate; 4-hydroxybutyl (meth)acrylate, 3-hydroxypentyl (meth)acrylate, 6-hydroxynonyl (meth)acrylate, 2-hydroxy and 5-hydroxypentyl (meth)acrylate; 7-hydroxyheptyl (meth)acrylate and 5-hydroxydecyl (meth)acrylate, diethylene glycol mono(meth)acrylate, polyethylene glycol mono(meth)acrylate, propylene glycol mono(meth)acrylate, polypropylene glycol mono(meth)acrylate, (meth)acrylates combining ethoxylation and propoxylation, caprolactone-2-hydroxyethyl acrylate adducts and mixtures thereof.

9. The oligomer according to claim 1, wherein the hydroxy(meth)acrylate comprises 2-hydroxyethyl acrylate (HEA), 2-hydroxyethylmethacrylate (HEMA), polypropylene

glycol monoacrylate, polyethylene glycol monoacrylate, caprolactone-2-hydroxyethyl acrylate adducts, and mixtures thereof.

10. The oligomer according to claim 1, wherein the acrylic backbone further comprises styrene, allylic derivatives of styrene, or vinylic derivatives of styrene.
11. The oligomer according to claim 1, which comprises residues in the following order : hydroxy(meth)acrylate - (diisocyanate - acrylic polyol)<sub>n</sub> - diisocyanate - hydroxy(meth)acrylate  
where n is 2 to 6.
12. The oligomer according to claim 1, which has an unreacted hydroxy(meth)acrylate content of less than 1% by weight.
13. The oligomer according to claim 1, which has an unreacted hydroxyethyl acrylate content of less than 1% by weight.
14. The oligomer according to claim 1, which has a diisocyanate diacrylate content of less than 5 % by weight.
15. A one pot process for making the oligomer according to claim 1, which comprises reacting the acrylic polymer polyol, diisocyanate, and hydroxy(meth)acrylate to obtain the oligomer according to claim 1.
16. The one pot process according to claim 15, wherein the acrylic polymer polyol and diisocyanate are reacted to obtain a reaction product, which reaction product is then reacted with the hydroxy(meth)acrylate.
17. The one pot process according to claim 15, wherein the diisocyanate and hydroxy(meth)acrylate are reacted to obtain a reaction product, which reaction product is then reacted with the acrylic polymer polyol.

18. The one pot process according to claim 15, which is conducted without a solvent.
19. The one pot process according to claim 15, which is performed without stripping of solvent, unreacted hydroxy(meth)acrylate or diisocyanate.
20. An energy curable ink composition, which comprises the oligomer according to claim 1.
21. The ink composition according to claim 20, which further comprises at least one ingredient selected from the group consisting of pigments, resins, diluents, waxes, greases, plasticizers, stabilizers, photoinitiators, curing agents, thickeners, fillers, inhibitors, wetting agents, flow agents, leveling agents, and adhesion promoters.
22. The ink composition according to claim 20, which is energy curable with actinic or ionizing radiation.
23. The ink composition according to claim 20, which is substantially water free and solvent free.
24. An article of manufacture, comprising a substrate having a surface coated with the energy curable ink composition according to claim 20, wherein the ink composition is a laminating ink composition.
25. An article of manufacture, comprising a substrate having a surface coated with the energy curable ink composition according to claim 20, wherein the ink composition is a lithographic ink composition.
26. An article of manufacture, comprising a substrate having a surface coated with the energy curable ink composition according to claim 20, which has been subjected to energy curing.

27. The ink composition according to claim 20, which has a color of black, cyan, magenta or yellow, a low ink misting of  $\Delta E \leq 6$ , and a 90-100% adhesion to vinyl, polystyrene and polycarbonate.